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PRESENTATION OF THE REMEDIAL INVESTIGATION

OF

**PHILLIPS ISLAND
SUNOCO, Inc. (R&M)
MARCUS HOOK REFINERY
MARCUS HOOK, PENNSYLVANIA**

APRIL 18, 2000



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Purpose and Objectives

◆ PURPOSE

- ☒ Present the Results of the Act 2 Investigation
- ☒ Discuss Potential Remedial Actions

◆ OBJECTIVES

- ☒ Obtain Cleanup Plan Approval as Expeditiously as Possible

Introduction

Background

**Remedial
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Outline of Presentation

- ◆ Introduction
- ◆ Background
 - ☑ Site Status
 - ☑ Site History
 - ☑ Potential Exposure Pathways
- ◆ Remedial Investigation
 - ☑ Remedial Investigation Activities and Results
 - ☑ Risk Assessment Status
- ◆ Remedial Actions
 - ☑ Discussion of Conceptual Remedial Actions

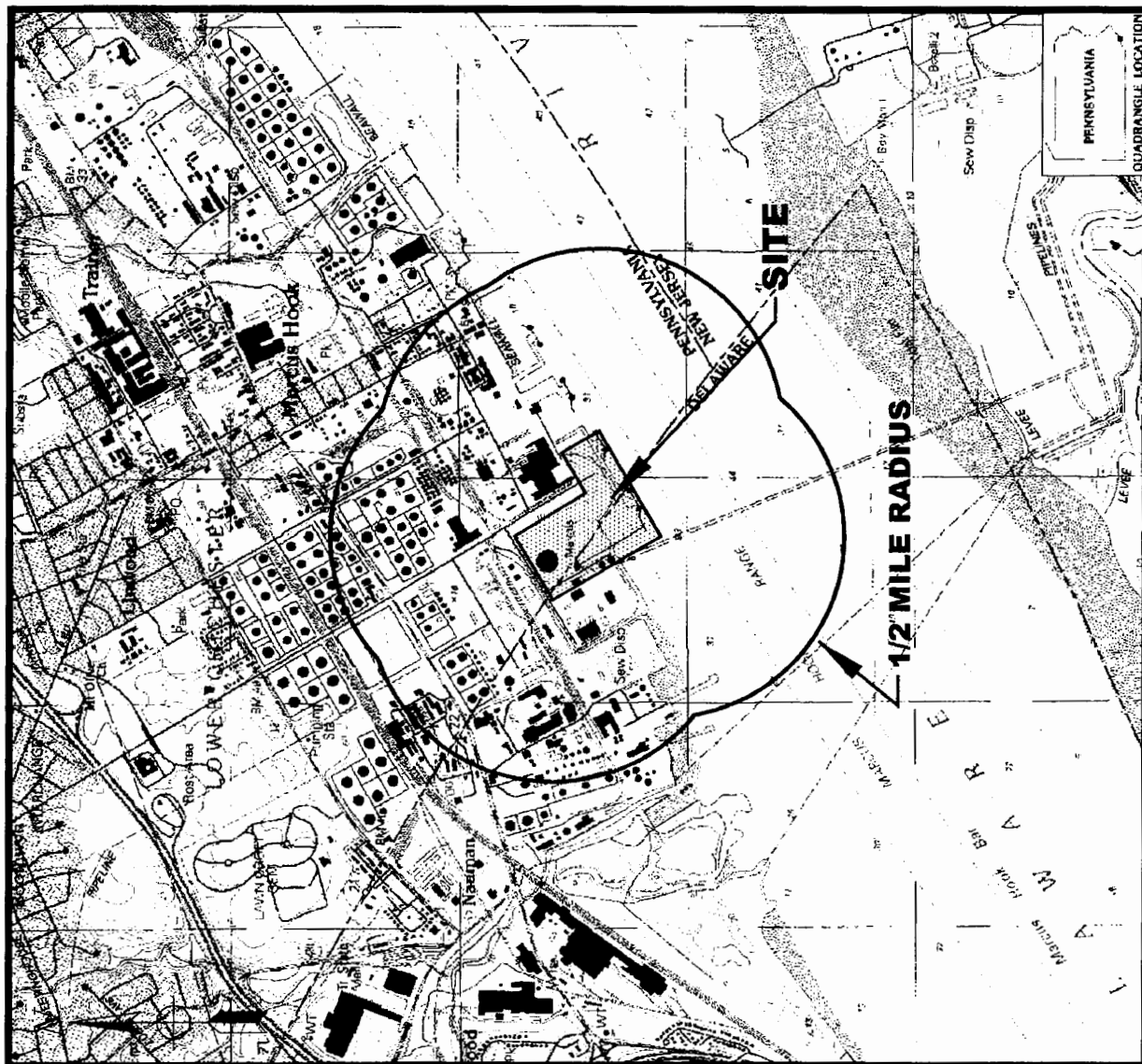
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Site Status

◆ CURRENT CONDITIONS

- ☑ 21.1 Acres of Island under Act 2 Consideration
- ☑ Closed Former Fill Area
- ☑ Ancillary Refinery Operations
 - Firefighting Training Area
 - Sandblasting Area
 - Roll-Off Container Staging
- ☑ Operating Under Comprehensive Remedial Action Plan
 - Covers Entire Refinery Including Phillips Island
 - Approved by PADEP in 1996
 - Phillips Island Remedial Action - LNAPL Removal
 - Progress Reports Submitted To PADEP

Introduction

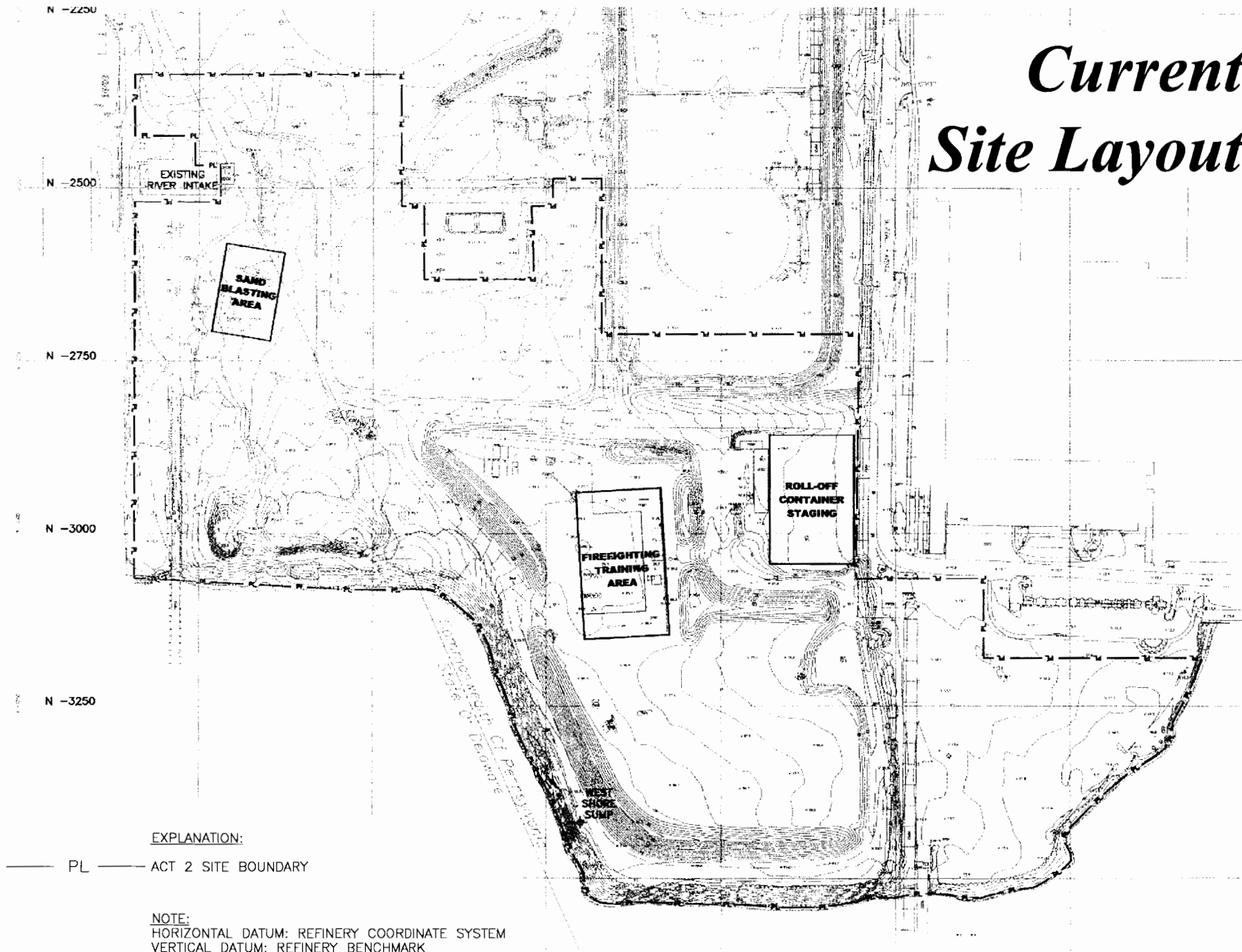
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Current Site Layout





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Planned Future Use

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- ☑ Construct a Co-Generation Power Station Primarily Fueled by Natural Gas
- ☑ Eliminate Some Refinery Boilers with Net Reduction in NOx and SOx
- ☑ Develop a Brownfield Site
- ☑ Expand Local Tax Base
- ☑ Bring Jobs into the Area

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Site History

CIRCA 1930's

- ◆ Part of a Quarantine Station For Ships

CIRCA 1930's to 1941

- ◆ Owned by the Phillips Family
- ◆ Sunoco Purchased the Island from the Phillips' in 1941

1941-1950

- ◆ Stone Bulkhead was Constructed in the River
- ◆ Backfilled With Iron Pyrites, Debris

1950-1966

- ◆ Constructed a Second Bulkhead
- ◆ Backfilled With Spent Filter Clay, Clean Fill, Demolition Debris
- ◆ Spent Filter Clay was Mixed With Clean Clay and Compacted on the Island



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Site History (Continued)

1966-1980

- ◆ Constructed a clay berm/dike (present Delaware River bank)
- ◆ Dike is approximately 30 to 35 feet high
- ◆ Backfilled with spent filter clay, clean fill, demolition debris
- ◆ Ceased fill operations in 1980

1985

- ◆ Site is re-graded with up to 18,000 tons of soil mixed with flyash

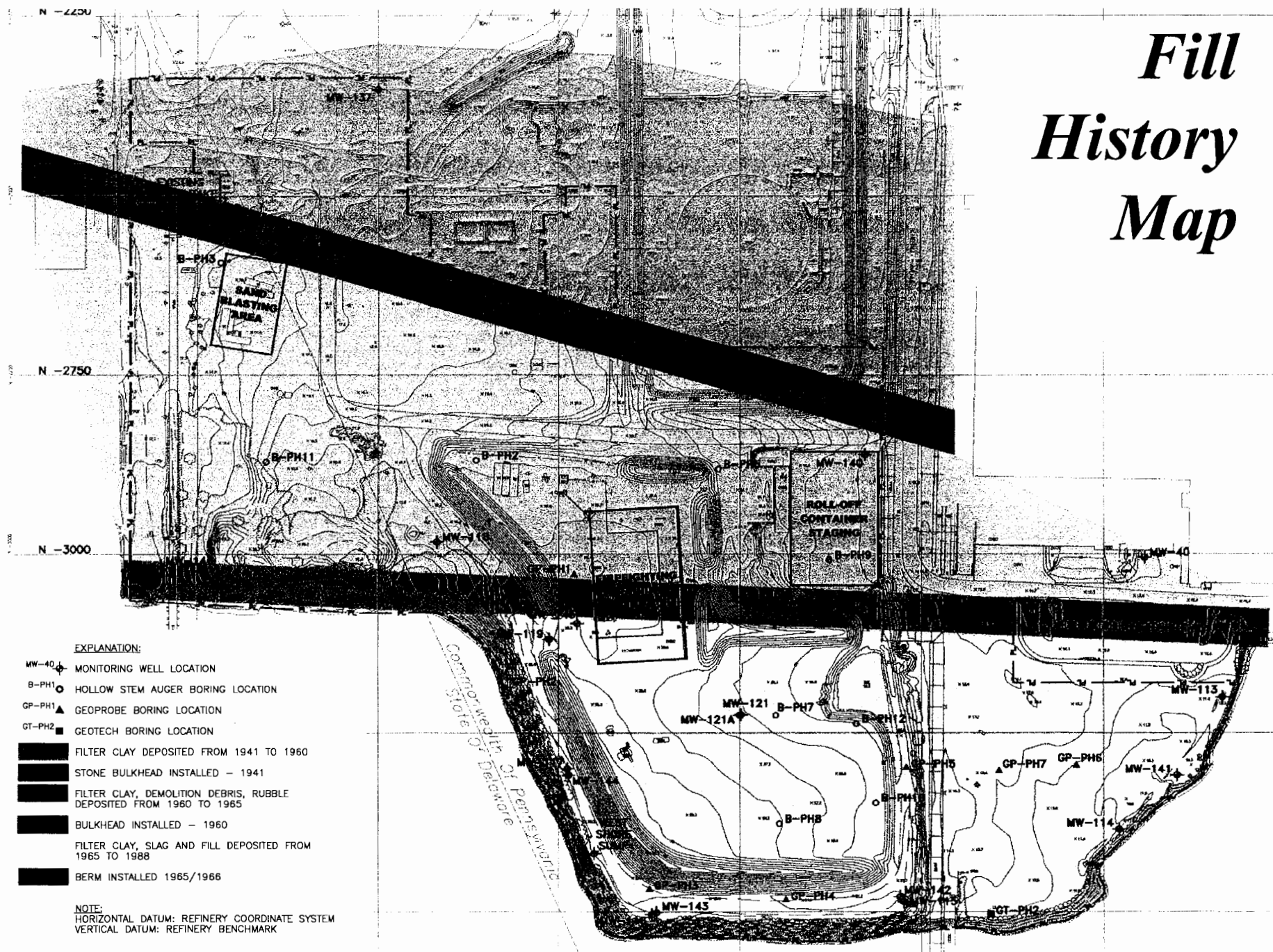
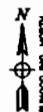
Early 1990's

- ◆ Site is re-graded with soil from construction of stormwater tanks in conjunction with the Middle Creek project

1996

- ◆ LNAPL recovery begins

Fill History Map





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Previous Investigations

- ◆ **NUS - PRELIMINARY ASSESSMENT OF MARCUS HOOK REFINERY (EPA, 1987)**
 - ☑ No Supply Wells Within 3 Miles
 - ☑ No Public Water Intakes within 3 miles of Refinery
 - ☑ Surrounding Land Use Is Industrial
 - ☑ No Critical Environments Within 3 Miles

- ◆ **ERM, Inc. - SUBSURFACE INVESTIGATION AND SCREENING STUDY (1990)**
 - ☑ Commissioned By Sunoco
 - ☑ Detected VOCs, PAHs, Pesticides and Metals in Soil
 - ☑ Concluded That Containment Coupled With Infiltration Control is Protective of Human Health and the Environment



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Previous Investigations (Continued)

- ◆ A.T. Kearney, Inc. - PHASE II FINAL RCRA FACILITY ASSESSMENT (EPA, 1991)
 - ☑ RFA Identified Surface Soil Staining Near Operational Areas
 - ☑ Did Not Identify Immediate Indications of Impacts From Fill Area
 - ☑ Recommended a Subsurface Investigation
- ◆ GES, Inc. - GROUNDWATER ASSESSMENT (1995/1996)
 - ☑ Groundwater hydrology is complicated (tidal impact)
 - ☑ No apparent hydraulic connection between fill area and river
 - ☑ LNAPL present in the waste filter clay



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Conceptual Site Model

◆ SITE CHARACTERISTICS

- ☑ The site contains filter clay; leaded sludge; rubble; demolition debris; and general refuse.
- ☑ The site is covered with a soil layer underlain by fill material composed of soil mixed with flyash.
- ☑ The waste and fill materials contain petroleum-related compounds.
- ☑ LNAPL is present in wells in the waste material in the former fill area and at one seep.
- ☑ Groundwater quality data does not indicate a significant impact to groundwater from dissolved compounds. ?

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Conceptual Site Model (Continued)

◆ MIGRATION PATHWAYS

- ☑ The hydrology of the site is complicated. Groundwater elevation data indicate the Delaware River is recharging the groundwater system underlying the Island.
- ☑ The low permeability of the filter clay and the berm has isolated the waste and fill from the surrounding environment.

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Remedial Investigation Activities

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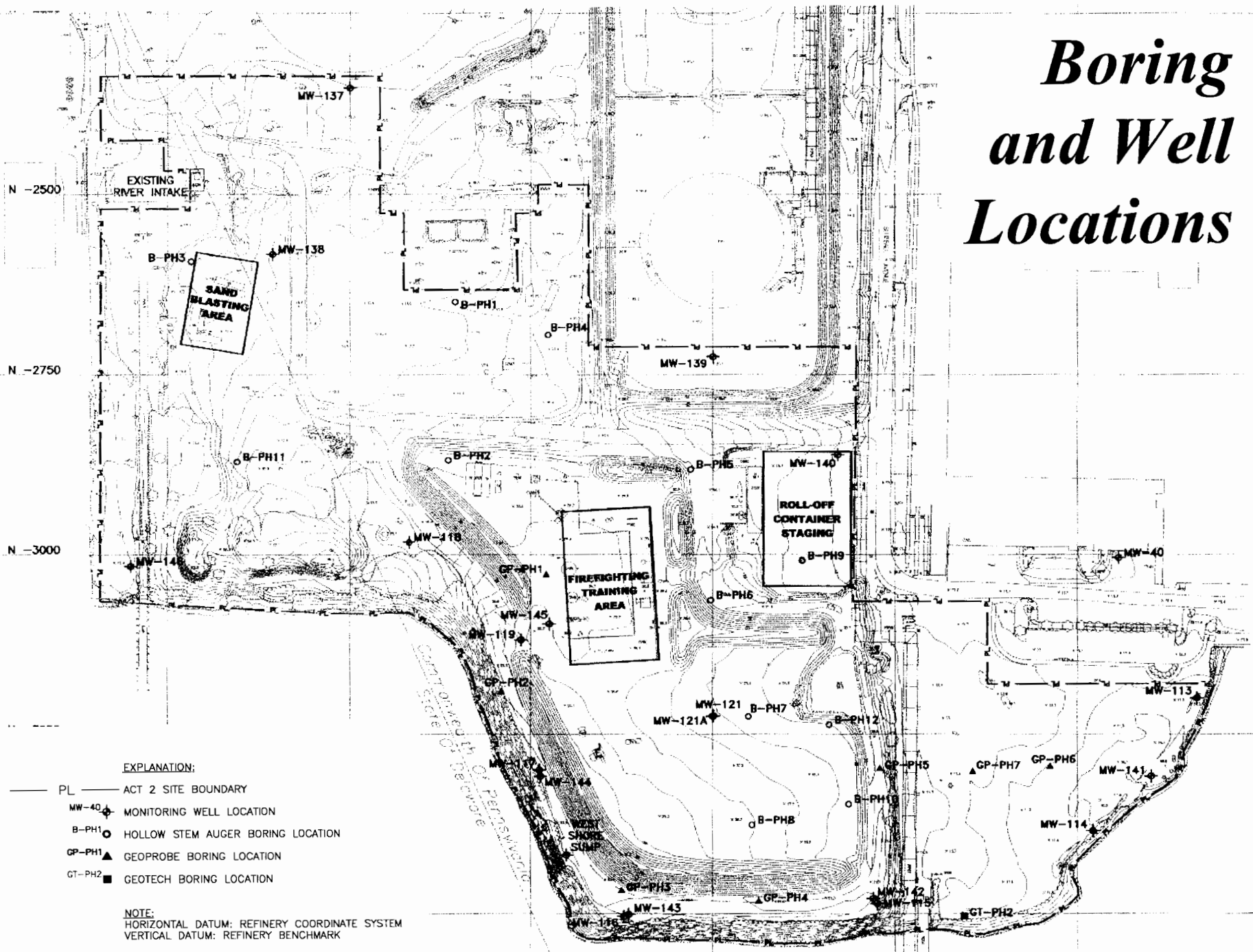
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- ◆ 29 Soil borings
- ◆ 78 Soil samples
- ◆ Installed 10 wells
- ◆ Collected 1 round of groundwater samples from 12 wells
- ◆ Collected 7 LNAPL samples
- ◆ Slug testing
- ◆ Geotechnical testing
- ◆ Water level monitoring
- ◆ Three pumping tests

Boring and Well Locations





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Physical Characteristics

HYDROGEOLOGY

◆ SOIL AND FILL

- ☑ Soil from stormwater tank construction at Middle Creek
- ☑ Clay with aggregate, brick fragments, and concrete rubble
- ☑ Generally extends from the ground surface to approximately 5 to 18 feet bgs

◆ WASTE

- ☑ Dense gray clay, debris, glass, gravel, wood, metal
- ☑ Extends from the base of the fill to approximately 42 feet bgs.
- ☑ Has a high water content
- ☑ Laterally discontinuous. The waste thickness in the eastern portion of the site is approximately 10 feet.



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Physical Characteristics HYDROGEOLOGY (Continued)

◆ INDIGENOUS SEDIMENTS

- ☑ Primarily of gray silty clay (average hydraulic conductivity of 0.02291 ft/day) - *field data*
- ☑ Some areas farther inland are orange/brown sand and gravel (average hydraulic conductivity of 6.87 ft/day) *field data*

◆ LNAPL SEEPS

- ☑ One seep is located approximately 10 feet down the slope. LNAPL is recovered from this seep.
- ☑ Several small seeps are located near the water line along the bank. The LNAPL appears to follow bedding planes in the clay.

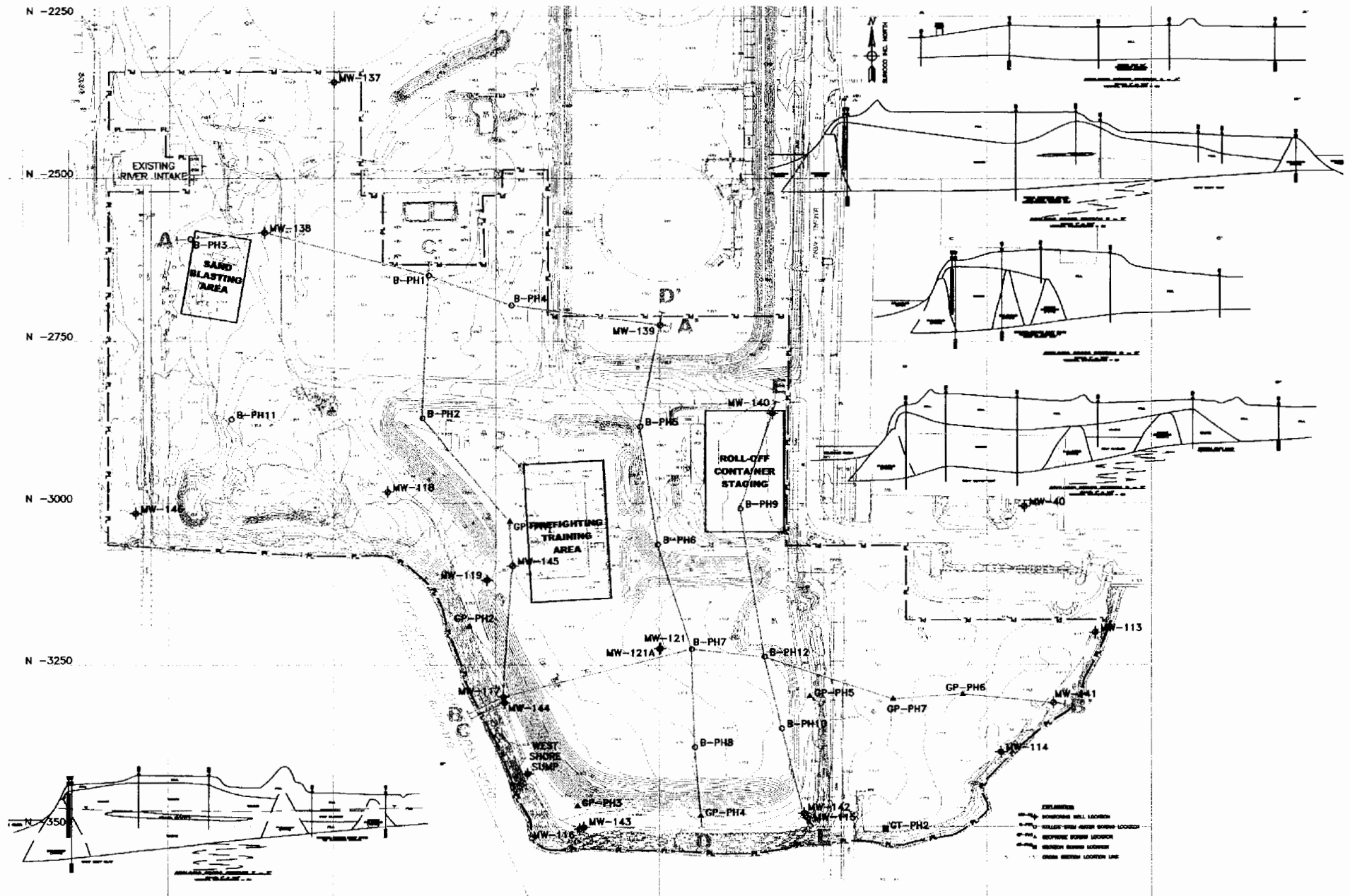
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Physical Characteristics

HYDROLOGY

◆ GROUNDWATER

- ☑ The highly variable head measurements indicate the waste material is not in direct communication with the indigenous sediments
- ☑ Low permeability of the fill and waste materials restricts water infiltration
- ☑ Groundwater occurs in the indigenous sediments under semi-confined conditions
- ☑ Groundwater flow in the sediments is to the south toward the Delaware under an average hydraulic gradient of 0.0225
- ☑ Tidal influence ranges between 0.05 feet to 0.29 feet
- ☑ The transmissivity of the waste material ranges between 0.032 and 11.4 gpd/ft.
- ☑ Calculated drawdown radii for the waste materials were between 0.15 and 62 feet.

Low $Q \sim 0.0001$ gpm

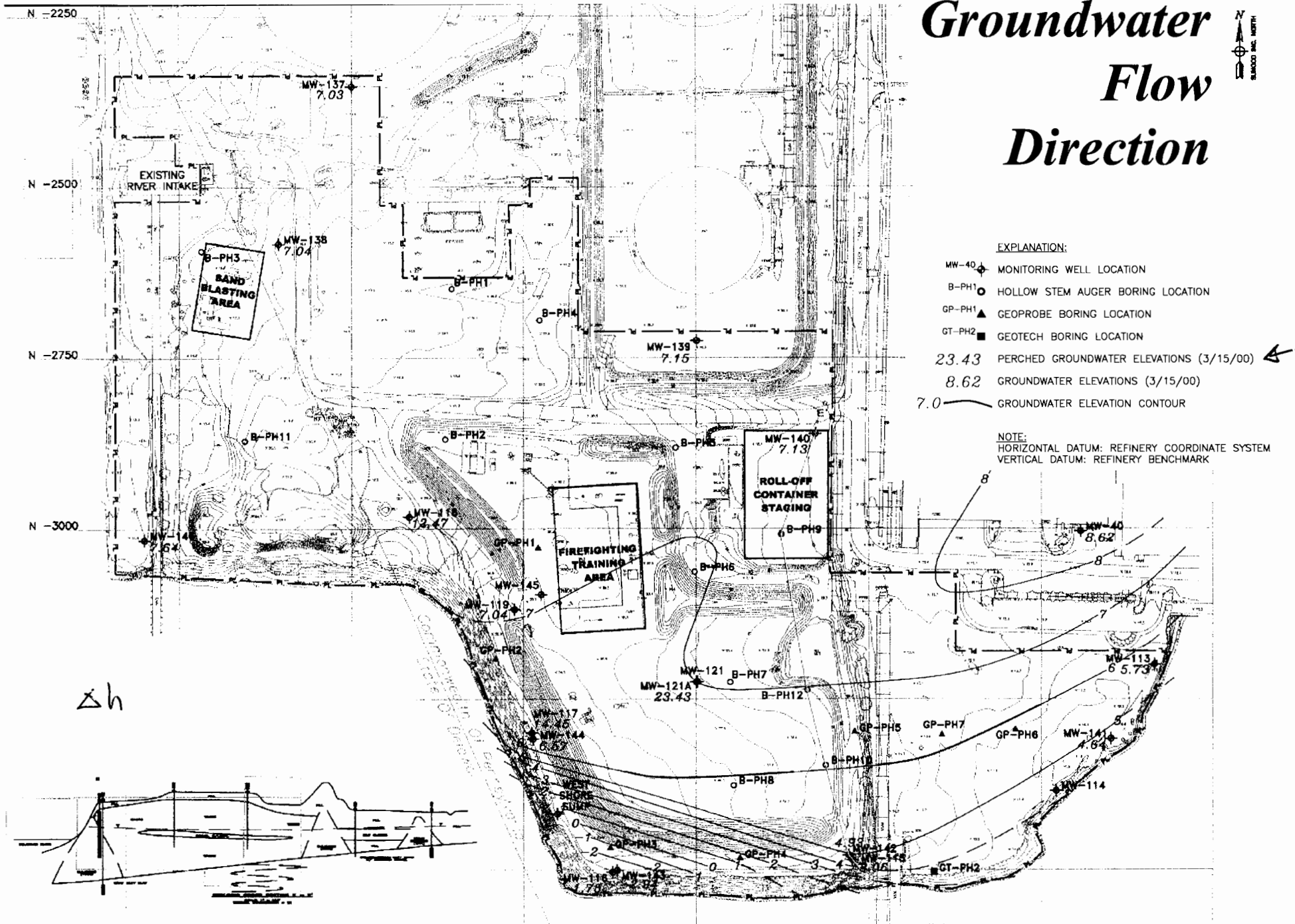
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Physical Characteristics

LNAPL

$\rho = 0.92$
motor oil

- ☑ Detected in monitoring wells installed in the waste and at seeps along the Delaware
- ☑ LNAPL was not detected in wells installed in the indigenous sediments
- ☑ Apparent LNAPL thickness ranged between 0.07 and 6.35 feet

(depends on where you put the well)

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N -2250

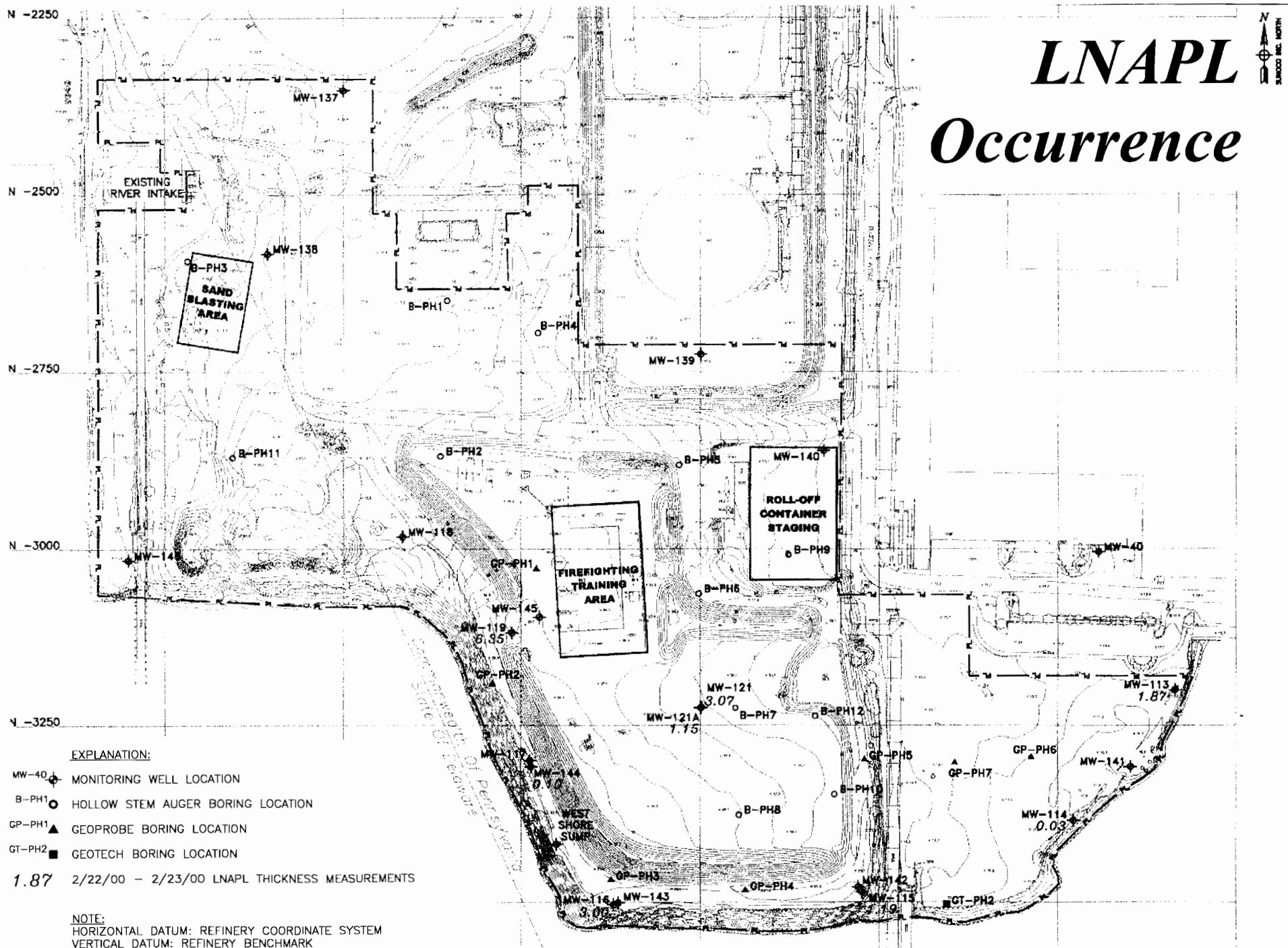
N -2500

N -2750

N -3000

N -3250

LNAPL Occurrence



EXPLANATION:

- MW-40 MONITORING WELL LOCATION
- B-PH1 HOLLOW STEM AUGER BORING LOCATION
- GP-PH1 GEOPROBE BORING LOCATION
- GT-PH2 GEOTECH BORING LOCATION

1.87 2/22/00 - 2/23/00 LNAPL THICKNESS MEASUREMENTS

NOTE:

HORIZONTAL DATUM: REFINERY COORDINATE SYSTEM
VERTICAL DATUM: REFINERY BENCHMARK

Ground-water Chemical Results

DICHLOROMETHANE 20 ug/L
METHYL TERTIARY BUTYL ETHER 120 ug/L

ARSENIC 0.14 mg/L

ARSENIC 0.051 mg/L
METHYL TERTIARY BUTYL ETHER 51 ug/L

ARSENIC 0.087 mg/L
BENZENE 50 ug/L

ARSENIC 0.51 mg/L
LEAD 0.031 mg/L

BENZENE 6 ug/L
LEAD 0.06 mg/L

ARSENIC 1.3 mg/L
CADIUM 0.007 mg/L
LEAD 0.008 mg/L

ARSENIC 0.087 mg/L
LEAD 0.073 mg/L
4-METHYLPHENOL 220 ug/L

EXPLANATION:
ACT 2 SITE BOUNDARY
MONITORING WELL LOCATION
HOLLOW STEM AUGER BORING LOCATION
GEOPROBE BORING LOCATION
GEOTECH BORING LOCATION

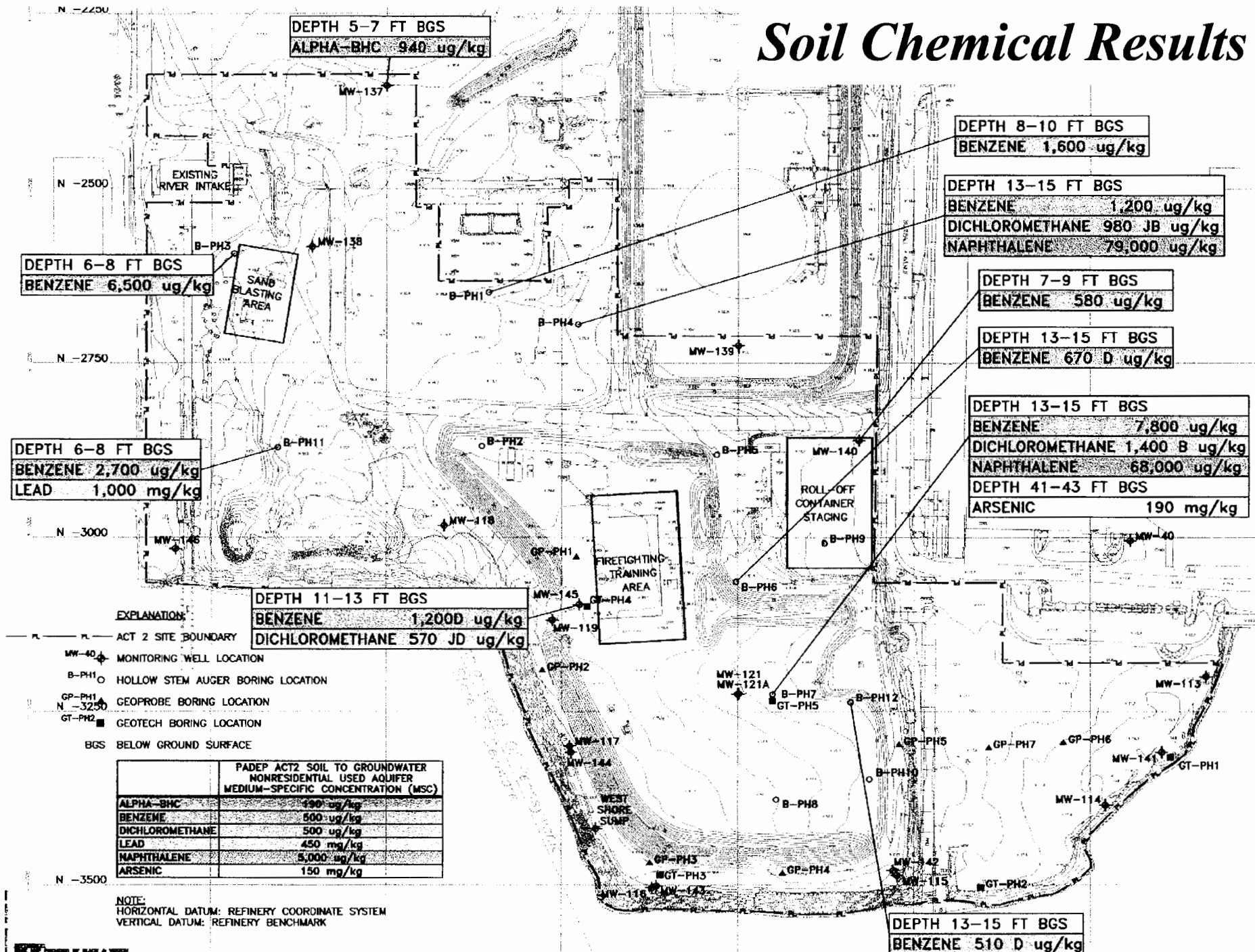
	PADEP ACT2 NONRESIDENTIAL USED ADJUFER MEDIUM-SPECIFIC CONCENTRATION (MSC)
ARSENIC	0.05 mg/L
BENZENE	5 ug/L
CADIUM	0.005 mg/L
DICHLOROMETHANE	5 ug/L
LEAD	0.005 mg/L
4-METHYLPHENOL	100 ug/L
METHYL TERTIARY BUTYL ETHER	20 ug/L

	PADEP ACT2 NONRESIDENTIAL USED AQUIFER MEDIUM-SPECIFIC CONCENTRATION (MSC)
ARSENIC	0.05 mg/L
BENZENE	5 ug/L
CADMIUM	0.005 mg/L
DICHLOROMETHANE	5 ug/L
LEAD	0.005 mg/L
4-METHYLPHENOL	100 ug/L
METHYL TERTIARY BUTYL ETHER	20 ug/L

ARSENIC	0.087 mg/L
LEAD	0.073 mg/L
4-METHYLPHENOL	220 ug/L

ARSENIC	1.3 mg/L
CADMIUM	0.007 mg/L
LEAD	0.008 mg/L

Soil Chemical Results



"stuff" hanging around the fills.



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Results of Fate and Transport Analysis

◆ DOMINECO MODELING

- ☑ Calculates the natural degradation of COPCs over time and distance
- ☑ Used the most conservative values for the site
- ☑ Results indicate that concentrations of COPCs will be less than groundwater MSCs within 50 feet of the source

◆ SURFACE WATER IMPACT ASSESSMENT

- ☑ Assessed the potential impact on surface waters from groundwater
- ☑ Back-calculated the groundwater concentration necessary to exceed the surface water quality criteria

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Results of Fate and Transport Analysis (Continued)

◆ SURFACE WATER IMPACT ASSESSMENT (Cont.)

☑ To exceed surface water criteria, site groundwater must exceed the surface water standards by: ^{DEP!}

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- benzene - 4 orders of magnitude
- methylene chloride - 5 orders of magnitude
- 4-methylphenol - 6 orders of magnitude
- arsenic - 6 orders of magnitude
- cadmium - 4 orders of magnitude
- lead - 4 orders of magnitude
- PAHs - must exceed solubility

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Results of Fate and Transport Analysis (Continued)

◆ CONCLUSIONS

- ☑ Soil permeability is sufficiently low to naturally attenuate COPCs over short distances
- ☑ COPC migration will be governed by chemical diffusion rather than groundwater advection

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Chemicals of Potential Concern

Groundwater

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Chemicals Detected Above the Non-Residential Use Aquifer MSC

- ☒ Benzene
- ☒ Dichloromethane (Methylene Chloride)
- ☒ Methyl Tertiary Butyl Ether (MTBE)
- ☒ 4-Methylphenol (Cresol)
- ☒ Arsenic
- ☒ Cadmium
- ☒ Lead



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Chemicals of Potential Concern

SURFACE SOIL

Chemical	Exceeded Direct Contact (0-2 ft)	Exceeded Soil to Groundwater Pathway
Methylene chloride	No	Yes
4,4'-DDD	No	Yes
Alpha-BHC	Yes*	Yes
Beta-BHC	No	Yes

* Detected at one location and at a concentration 10 percent greater than the MSC

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Chemicals of Potential Concern

UNSATURATED SUBSURFACE SOIL

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Chemical	Exceeded Direct Contact (0-2 ft)	Exceeded Direct Contact (2-15 ft)	Exceeded Soil to Groundwater Pathway
Methylene chloride	No	No	Yes
Benzene	Yes*	Yes*	Yes
Naphthalene	No	No	Yes
Arsenic	Yes^	No	Yes
Lead	No	No	Yes

*Detected in one sample

^Detected in three samples



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Chemicals of Potential Concern

SATURATED SUBSURFACE SOIL

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Chemical	Exceeded Direct Contact (0-2 ft)	Exceeded Direct Contact (2-15 ft)	Exceeded Soil to Groundwater Pathway
Arsenic	Yes*	No	Yes

*Detected in three samples



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Ecological Assessment Findings

- ◆ No critical habitats
- ◆ No endangered, threatened, or special concern species identified on the Island
- ◆ Conclusion: Ecological receptors unlikely to be a significant pathway of concern

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Exposure Pathways for Assessment

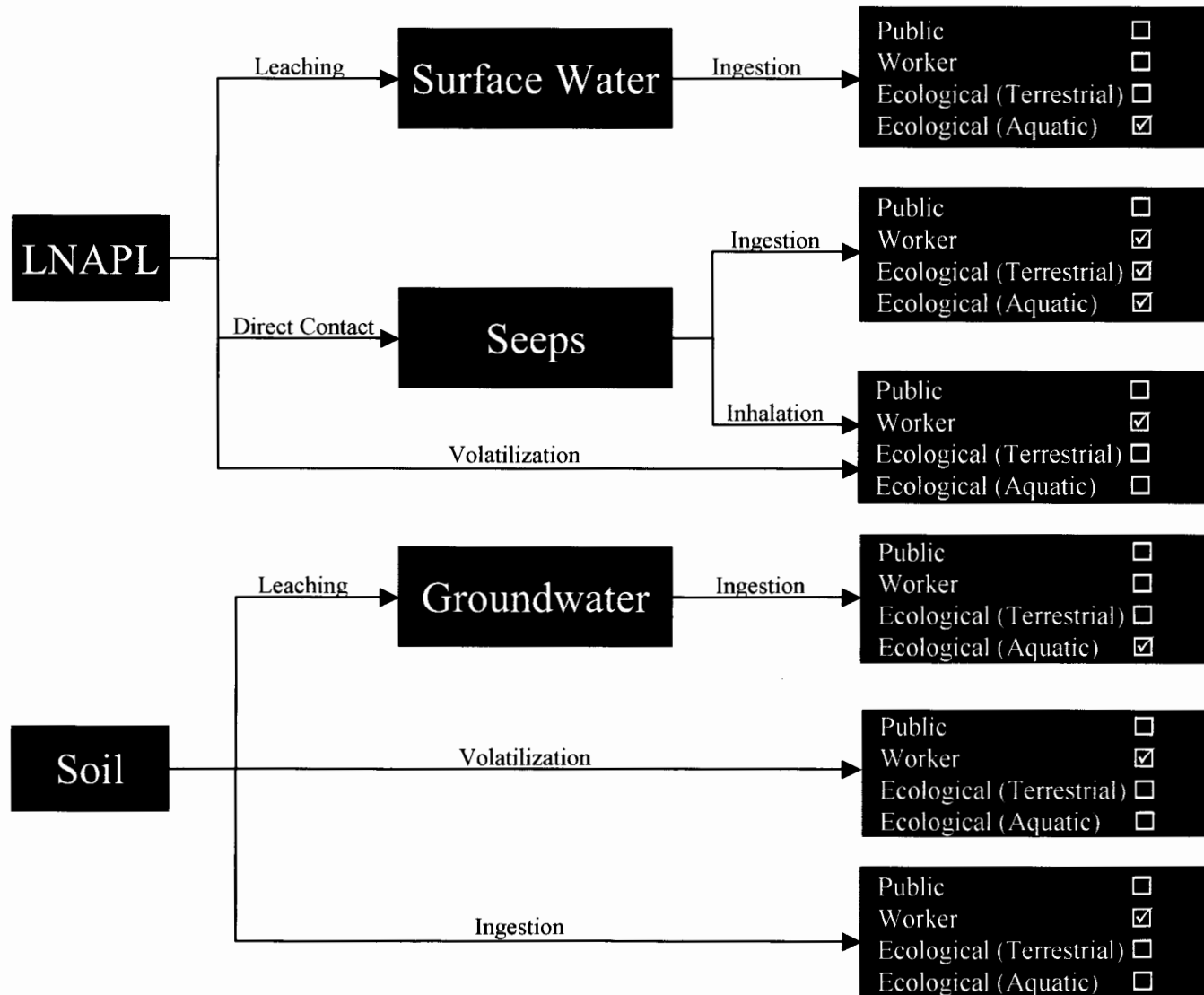
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Preliminary Summary of Findings

- ◆ The site consists of waste and fill material overlying natural sediments
- ◆ Groundwater occurs under semi-confined conditions in the natural sediments
- ◆ Groundwater contains low concentrations of dissolved compounds
- ◆ LNAPL occurs within the waste and seeps out at several locations along the Delaware River bank
- ◆ The soil at the site contains compounds above the soil to groundwater MSCs
- ◆ The surface and subsurface unsaturated soil COPCs did not exceed the direct contact MSCs except for isolated occurrences
- ◆ Despite their detection in the soil above the soil to groundwater MSCs, many compounds were not detected in the groundwater above the non-residential use aquifer MSCs
- ◆ The preliminary results of the risk assessment indicated that:
 - ☑ The potential for exposure for current and future workers is likely to be insignificant
 - ☑ Ecological receptors are likely only at risk from direct exposure to LNAPL seeps



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Remedial Action

- ◆ Enhance LNAPL Recovery
- ◆ Passive Vapor Control *→ underneath the slab*
- ◆ Stormwater Collection/Infiltration Minimization
- ◆ Seep Control *→ collects storm water and then to POTW*
→ project 2/+ years to control

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